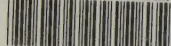


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THE
"MACHINERY"
OF LIFE.

DR. BEALE

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A LECTURE

BY

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THE
"M A C H I N E R Y"
OF LIFE.



WE have been assured that we are "machines," but we have not been told in what particulars we resemble *machines*, nor has the particular *machine* which we are supposed to be most like been pointed out. But some, who are pronounced to be high authorities in science, assert that we are *machines*, and protest that what they affirm is literally true.

But, on the other hand, is there one of us who does not feel perfectly certain that, though he may not be able to adequately explain why, he is not in any essential points like any machine that he knows of, or any machine of which he has heard from others. Has not every machine of which we have any experience been made in separate pieces, which have been afterwards put together? But has any one of us, any animal, plant, or living organism, or any part of any living thing in nature, been formed in separate pieces, which, after having been finished and properly adapted, were fitted together? Nevertheless, it is certain that many eminent persons assert that all living

things are machines, and declare the assertion to be rigidly correct.

No machine grows. No machine yet made repairs itself if damaged, or produces machines like itself, or makes up for the wear and tear resulting from its working, if the crude materials out of which the machine has been made be placed ever so close to it. On the other hand, every living thing does grow, and may repair itself after injury. Living things appropriate crude inactive materials, and so their waste in action is made up. Living things are capable of multiplying, and the new beings produced are in all respects as powerful as the beings from which they sprang. Although all living things do these things, while no non-living machine can do any one of them, it is affirmed that living things are machines.

Again, can any machine, however perfect and elaborate in its construction, be trained and educated even to the degree possible in the case of the most stupid dog? But has not Mr. Huxley remarked that "it is because the human body is a machine that education is possible?" And yet no one has succeeded in educating watches, steam-engines, or windmills. Will it be suggested that it has been decided that the human machine should have the prior claim, and that therefore it is to be educated before its mechanical brethren are taken in hand?

But if we appeal to nature and refuse to believe these dogmatic assertions until it shall be shown they rest on something more than mere authority, what do we learn? If we examine the bodies of man and animals and plants, do we discover anything in them like any machinery we are acquainted with, or about which we can learn anything from

others? I have been studying the structure of the bodies of living beings for many years; and if any one put the question to me, "Is the assertion that 'the body is a machine' *true* or *false*?" I certainly could not reply that the assertion was true, or that it was ever likely to prove true.

Muscle is the structure upon which most of the movements of animals and man depend. We may see, in the case of some of the lower animals, this muscular tissue contracting under the microscope. No machine moves like it. Nor can anything be constructed that exhibits movement like that of muscle. If this could be done, the machine constructed upon the principle of muscle would be most valuable, for muscle is the most economical of all the forms of motor apparatus known. But for this perfect contractile material we must go to the body of a living animal. Muscle is characteristic of many living beings, but it is found in the living world only. Again, we may see transparent structureless living matter moving in various directions, under the microscope, and in a manner which is peculiar to it. No substance in nature manifests movements at all like those of living matter. But we are enjoined to believe and confess, and to accept upon faith the dogma, that the movement depends upon *machinery*. The machinery referred to can exist only in the imagination. We are told that "thought is as much a function of matter as motion is," and due to the action of the machinery of the brain. We ask what sort of machinery is found in brains and beings, and how it is arranged. We are informed that it is "atomic" and that it is "molecular." We further beg to be shown the mechanical atoms and molecules. We ask how they are formed, and how fitted

together? But alas! the atoms and molecules are all beyond the microscopic limit. We cannot see them, but they are material atoms, in which a physicist discerns "the promise and potency" of life.

Although no one has produced any machine that is conscious, or pointed out any living thing that acts like a machine, it is affirmed that animals are conscious machines. But as no machine is conscious and nothing that is conscious is a machine, it is surely needless to feel alarmed at the terrible consequences of the application of the doctrine to ourselves. Probably most thoughtful people will feel quite convinced that the living leaders of scientific thought are certainly not machines, as no machines could exhibit the inconsistencies and contradictions which characterise their labours. The very "machines" which profess to be influenced only by observation and experiment, have discarded their professions and have become somehow transformed into sceptical machines which trust the imagination only and believe and teach fiction, and persuade themselves and others they are machines which exist only in their inner consciousness and which have no objective existence whatever. But perhaps the most marvellous feat ever performed by any machine conscious or unconscious, was that of discerning in matter "the promise and potency of all terrestrial life" in the month of August, and discovering in the next month, in the presence of stronger and healthier thought that the doctrine dissolved and disappeared.

It is not wonderful that the request for further explanation of the doctrine that living things are machines, should only have been answered, on the part of authority, by ill-disguised scorn. But it is very wonderful that unproved

and unprovable assertions, after having been repeated again and again, and as many times refuted, should nevertheless be believed to be true by many, should be half believed by many more, and provisionally accepted probably by thousands of intelligent persons, although it has been shown that there is not for them the slightest foundation in fact. Nay, it is almost admitted, in the very memoirs in which the assertions are made, that they cannot at this time be proved to be true, and instances can be found, in which it is admitted by a teacher of the new Philosophy, that, although what he says is not susceptible of proof, he assures his readers that *he* is thoroughly convinced of the truth of the doctrine he teaches, *because* he feels sure that in the years to come it will be proved to the satisfaction of persons who will at that time be alive, and also *because* it would seem that he enjoys a monopoly of the power of conducting scientific research in the imagination. This power of anticipating the results of future work and enquiry, enables him to solve problems of which no one else even dares attempt the solution, and which would have perhaps remained insoluble for ever, but for the advantages he enjoys over all but a very few of his fellow-creatures who belong to the class of "privileged spirits." This sort of claim to the possession of special faculties and peculiar powers, even to a sort of scientific infallibility has been recently set up by more than one authority. It has been suggested that those competent to judge whether we are or are not machines, do not amount to more than one per million of the population! All the men known to Mr. Spalding, who "at once understand and accept the doctrine that we are conscious automats," do not number more than five. It is, however,

quite certain that the number who accept the doctrine without understanding it is very large, while the number of those who understand the doctrine and cannot accept it is by no means very small, but it is quite possible that those who understand the doctrine as Mr. Spalding desires do not number five. I should think that no one who knew much about the structure of the body of man, or of any animal, and had studied the movements of muscular tissue, of cilia, or of the living matter, would accept the doctrine "that the bodies of men and all animals are conscious machines, whose movements can never escape by a hair's breadth (!) from the inexorable rule of physical law." Mr. Spalding asserts the physical law without stating its terms, and he does not explain how the inexorable rule applies—for example, in the case of the movements of a white blood corpuscle. Let us hear by what physical law the growth of a blade of grass, and the development and growth of a hair, or the movements of a particle of living matter are ruled. Who cares to know the number of "competent persons" and "privileged spirits" who arrogantly pretend to knowledge which they cannot or will not convey to others? Any one who knows how a simple organism lives and grows, will be able to explain the phenomena so that all people of average intelligence will be able to understand. There is not a point in the structure of any living thing, however minute and complicated the organism may be, that cannot be clearly rendered and made thoroughly intelligible to any one having ordinary sense and ordinary patience. Scientific truth is not for a clique, and any scientific men who set themselves up as the only "competent persons" to judge concerning scientific ques-

tions of interest to all mankind, not only make themselves more ridiculous than any infallibles of whose power some are so absurdly jealous, and whom they strive in vain to depose, but what is really serious, they bring discredit upon science. The same strictures apply to those who attempt to carry by general applause, pet scientific crotchets, and to obtain the support of numbers in favour of some scientific conjecture which no thoughtful person could be induced to admit was reasonable. But not only have certain doctrines been artificially forced into notoriety, but opponents have been authoritatively cautioned not to raise any objections to their acceptance. The President of the British Association thinks it right to inform the public, that Mr. Darwin is "The Most Terrible of Antagonists," and the fate of any who venture to differ from him in opinion, is indicated, in very plain English. "Without a trace of ill temper," Mr. Darwin "moves over the subject with the passionless strength of a glacier, and the grinding of the rocks is not always without a counterpart in the logical *pulverization* of the objector." Again, who would dare to differ from the dicta of another favoured speculator, who, according to the President, is not only an "Apostle of the Understanding," but is fortunate enough to possess "ganglia sometimes the seat of a nascent poetic thrill?" These examples are sufficient to show the sort of flourish considered advantageous or necessary in these days, if even well known authors of scientific views are to be recommended as worthy of public confidence.

But scientific authorities who speak in such terms of those upon their own side, must surely have some little misgiving in their own minds which they are trying to

conceal by the intensity of their approbation and the vehemence of their demeanour before the public. I should imagine there must be very few scientific men who would not prefer the obscurity of a student of nature to the glory of being held up as an "Apostle of the Understanding," with ganglia and nascent poetic thrills, or of being distinguished among men as the most terrible antagonist of his time, who, it is stated, moves like the cold crashing glacier, which, as we all know, after fruitlessly grinding and pounding away at the mountain sides for ages, slowly expires in the roaring torrent, which afterwards glides noiselessly along, and is at last buried in the boundless sea. The mountain be it observed, like truth, remains unshaken and uninjured through the ages and in spite of the scratching and grinding and ruin going on at its base, continues to point heavenwards in eternal purity and strength. Possibly the President may have intended to have said that Mr. Darwin stood still and firm like the mountain, instead of that he moved like a glacier. But most of us will fail to discern any likeness whatever between any scientific man and any mountain or any glacier.

Scientific men should appeal only to the intellect and reason of their intelligent fellow-creatures. If appeals of another kind become general, it is to be feared that the prosecution of science will be possible only for a very few. Relying upon the liberty and fair play which are in most matters characteristic of England, a scientific investigator should quietly pursue his work and publish the results of his enquiries even if the conclusions arrived at by him happen to be opposed to the dicta of authority, and expose him to the contempt of those who are so fortunate as to be

accepted as the "privileged spirits" of the day. But really if those who work at science are to be silenced by scientific men who are opposed to their views, and if people are to be terrified into believing the propaganda of a successful clique, and to be forced to accept as literally true, statements which have nothing to recommend them but the vigorous language in which they are conveyed and the seal of the authority who happens to be in power at the moment, it is desirable that the public should fully understand the circumstances under which scientific investigation is conducted. Then it has been said, such an hypothesis is true and ought to be accepted, and we have been told that we must accept it or go without any hypothesis at all, as if such a deprivation were a calamity not to be endured.

The extravagant views lately advocated have not been put forward by those who have been working in the particular department to which they relate, but by men who have earned reputation in altogether different fields of research. An authority perhaps upon light or sound deems it expedient to lay down the law upon the nature of life. A distinguished investigator in hydraulics might enlighten us upon the structure of nerve, and although from his remarks it might be pretty clear that he had no correct idea concerning the real structure and distribution of nerves, if he expressed himself with sufficient confidence, and his conclusions were spoken of in terms of praise by one or two scientific men, distinguished perhaps in mechanics and astronomy, but who had never seen a nerve, readers who were not specially informed, would naturally believe him to be an acknowledged authority upon the subject of which he was treating. Indeed, the most pertinacious advocates

of physical doctrines of life are not physiologists who have been studying the structure and actions of living beings, but physicists who have been engaged upon the investigation of non-living matter. Biology and Physiology are in fact now taught by men who ought to be teaching us physics. Astronomers and mathematicians may shortly be expected to leave the heavenly bodies and propound new and more startling theories about the origin of living beings than any yet proposed. But this is not all. Those who have studied living beings are spoken of contemptuously by their physical scientific brethren, some of whom really behave as if all fields of scientific research were exclusively their own. Those infatuated creatures who will not work under their direction and control, are to be dismissed with that crowd of "rash and ill-informed persons," who, "biassed by previous education," are opposed to the new revival of a very old philosophy.

Of the physicists who talk and write with the utmost confidence upon questions of the structure of living beings, some seem to be quite ignorant of the principles upon which enquiries into the minute structure of the bodies they call "machines" are conducted, and condemn microscopic enquiry as objectionable or mischievous. In this course they are undoubtedly supported by a section of the public and by many scientific men, who, in actively promoting what is called wide generalization, give their support to something widely different from science.

Assuredly those who desire to gain a hearing in order that they may tell what really has been disclosed in the course of microscopical investigation must, in these days, be patient. There is little hope for observers as long as the

public insist upon being told that people are machines and that all their actions are mechanical, and that all were once latent in a fiery cloud. This sort of thing diverts and excites, but much retards real enquiry, and until people are thoroughly tired of it, it is not likely they will listen to an account of things as they are, or enter very deeply into the study of natural knowledge.

Of late years the means of carrying out minute investigation have been much improved. Great advantages have been gained by improvements in object glasses. In 1860, Messrs. Powell and Lealand made for me a $\frac{1}{2\frac{1}{5}}$ magnifying 1800 diameters, and this was followed in 1864 by the $\frac{1}{5\frac{1}{10}}$ with an amplifying power of between 2,500 and 3,000. The same makers last year produced a $\frac{1}{8\frac{1}{10}}$, magnifying more than 4,000 diameters. Some notion of the degree of amplification obtained may be formed if I tell you that a mouse, if magnified in the same degree, would be as large as St. Paul's, and a man of ordinary stature would be higher than Mont Blanc. I was the first person to see the movements of bioplasm under one of these very high magnifying powers. Now what is to be seen when living matter is thus magnified? Machinery? By no means. We distinctly discern clear transparent structureless moving matter, which lives and grows. In it there is no indication of the presence of molecules or particles, I should say no structure, no *machinery* of any kind. But the physicists soon put observers and their observations out of court. They suggest to their admirers that we may be among the weak brethren, prejudiced persons, biassed by previous education, bigoted people who work within the microscopic limit. It is hinted that it is a matter of little consequence what is to be

seen, for are there not spirits privileged to discard observation altogether, who know how to use their liberty in exploring their own boundless imaginations and exercising their speculative faculties in fields of enquiry far beyond the microscopic limit? There, following out the principles of inexorable physical law, these gifted individuals are able to discern in the midst of what is clear and structureless, and without any magnifying powers whatever, the rigid fact of the presence of mechanical machinery having a "molecular structure." By the action of this they will be able to explain all the phenomena of living beings. They will persuade as many people as they can that they have discovered the exact truth, and I have no doubt that they will find plenty of people to believe that they know a great deal more about the "molecular structure" of living beings than any observers who have used the means now at disposal for observing minute structure. They will not be able to show to others the "molecular structure" they discern. But why should this be expected of them? Have not the diamond and the amethyst, and other crystals, structure of which no microscopist can make anything? Structure in these can, however, be discerned by the physicist. If, then, crystals have structure, which cannot be ascertained by the microscope, but can be proved to exist, may not the physicist argue that living matter, in which no structure can be discovered by the microscope, must also possess structure, and, of course, the very kind of structure possessed by crystals? Crystalline matter and living matter are, according to some authorities, closely related to one another! A living, moving, growing amoeba is supposed to be "like" a motionless crystal. We are expected to believe that from

the one form to the other is a transition no more abrupt than that by which matter in the colloid is separated from matter in the crystalline state. "Between the microscope limit and the true molecular limit," says the President of the British Association, "there is room for infinite permutations and combinations. It is in this region that the poles of the atoms are arranged, that tendency is given to their powers, so that when these poles and powers have free action and proper stimulus, in a suitable environment, they determine first, the germ, and afterwards, the complete organism!" After this lucid exposition of the things that have been discerned by a privileged spirit, who enjoys a monopoly of discovery in the fields beyond the microscope limit, and within the true molecular limit, I think you will agree with me in opinion that those who have worked within the microscope limit, and by means of observation and experiment, had better continue so to work, and not attempt to interfere with the permutations and combinations, and the poles of the atoms which are to be discerned by privileged spirits only beyond the limits of observation and experiment.

Not only has it been affirmed by authority that all living forms, man, animals, plants, and the simplest and most minute living particles, are machines and act mechanically, but it has been declared so positively that all the multitudinous living forms which are and have been upon our globe, have been derived by descent from primeval living matter of extreme simplicity, that I feel confident many consider this to be one of the scientific truths which really has been proved to demonstration. I shall not discuss this part of the question now, but I can assure you it is a view

not likely to advance beyond the state of hypothesis for a long time to come. But further, it is said, that the supposed primeval living matter was formed *direct from the non-living*. This statement, I venture to say, has no foundation in fact. It is a mere dictum, unsupported by observation, and there is not the slightest reason for supposing that it will ever prove to be correct. We may talk about fixed laws, but no one up to this day has been able to form the faintest conception of the manner in which the non-living was first made to live. The idea of gradual and progressive change from the non-living to the living is very generally assumed by a certain class of teachers, and accepted by their pupils as true, but it is the purest fancy to suppose that a single fact can be advanced in favour of the conjecture. The public has been led to suppose that from the inorganic to the organic is a transition of the same character as the transition which it is believed can be traced in passing from one living form to a higher one. But granting, for the sake of argument, the existence of the last, we should be compelled to deny the first. I do not say that the gradational steps assumed by evolutionists exist in fact, but I do distinctly assert that there is not a shadow of reason for supposing that under any circumstances conceivable, the *non-living* may, by a gradual series of modifications or transformations be converted direct into any *living*, however simple.

I will not dispute whether from primeval seaslime came *moner* and then *amæba*, which became covered with cilia and more complex, until a form appeared which "differentiated" into a creature having an outer and inner surface, which then became provided with a mouth. Nor will I object to the hypothesis of the development of the noto-

chord by an ascidian, and the passage to amphibia and mammalia, and lastly through the catarrhine monkeys to the earliest man. These may or may not be mere extravagant conjectures; but what concerns me now is the very first step from *the non-living to the living*. The easy manner in which this fact of the imagination is assumed, as if no one could doubt it for a moment, is very significant; but neither Hæckel nor any of his numerous followers has adduced any grounds for the conclusion that any living form came direct from non-living matter. The scientific man who professes to believe that any living form has ever been directly derived or evolved from the inorganic, must have unbounded faith in some methods which are beyond the limit of observation and experiment. There are no facts of science to support the hypothesis. Owen may have assured himself that it is more consistent with what is now known, "to suppose that the 'protogenal' jelly speck should be formable through concurrence of conditions . . . than that all existing 'protogens' are the result of a genetic descent from a germ cell due to a primary act of miraculous interposition." He may declare in favour of the "daily and hourly" formation of living beings by the conversion of physical and chemical into vital modes of force, but such declarations are entirely unsupported by evidence, and are conjectures only.

Dr. Tyndall exhibits some spherules of oil suspended in a mixture of alcohol and water of the same density as the oil itself, and straightway evolves from his imagination certain living creatures "like" the oil. It will be recorded that in the year 1874 the public were informed from the chair of the British Association for the advancement of Science,

that "there are organisms whose *vital* actions are almost as purely *physical* as that of these drops of oil!" Now you may dismiss this assertion as the purest fiction. It is one of the many discoveries recently made in imaginative science by an imaginative physicist who has discovered a new meaning of the word "like." But again, the President says, "trace the line of life backwards, and see it approaching *more and more* to what *we call* the purely physical condition" (!) I ask that but one single living thing be named which approaches the purely physical condition. This is another instance of the reckless assertion in which Dr. Tyndall so freely indulges. To talk of not stopping "abruptly where *our* microscopes cease to be of use," is an amusing suggestion. It is highly improbable that anyone who had used the microscope to any purpose would have made the remarks above stated. I beg anyone who may have had practice in microscopic inquiry, to examine attentively an amœba, and decide for himself whether it approaches the physical condition of any matter known. I ask him to consider whether there is the faintest shadow of truth in the assertion that, in the *protogenes* of Hæckel, we have "a type distinguishable from a fragment of albumen only by its finely granular character." The fallacy of such statements ought to have been exposed long ago. Doubtless they have misled many, and will yet mislead more; but there are many who desire to be misled, and who wish to persuade themselves to believe that there are living things the actions of which are entirely physical. Such persons seize upon every statement hazarded in favour of physical doctrine, and declare that at last the great physical life-truth has been discovered.

We may form some notion of what may be learnt concerning the changes which take place during the life of a living form so simple as that of a monad, by referring to the memoirs of Mr. Dallinger and Dr. Drysdale, published in the monthly *Microscopical Journal* for 1874. A glance at the facts disclosed by the investigations of these observers into the life history of simple monads will be sufficient to convince any unbiassed mind that such organisms, elementary as these must be, are really separated from non-living matter by a vast gulf. Each living organism, however simple it may seem when compared with beings far removed from it, has a life history of its own. Between any one form at any period of its development, and any form of mechanism, there is not the faintest analogy, or the remotest degree of likeness.

It is most difficult to get the real issue clearly placed before the public. Is the living separated from the non-living, or does the one pass into the other? Relying partly on the statements of Hæckel, Herbert Spencer, and others, many a teacher almost takes it for granted that every one will admit a type of living form scarcely distinguishable from non-living matter. Such an admission must not be thought of. The difference between the living and non-living is absolute. There is no transition, neither is there any true analogy between any form of non-living matter and any form of living matter. The line is clear, sharp, and defined. The gulf that intervenes is at this time impassable. It has not been and it cannot be bridged over. Instead of dogmatising upon the nature of mind, it would be more to the point if our confident teachers would give instances of particular non-living things and living things

which, according to them, approach very closely to one another. If they will but publicly state in what these are *like*, I shall with pleasure state in what they are *unlike*, and then the public will be in a position to decide whether the degree of likeness is most correctly denoted by the word "like" or "unlike."

As writer succeeds writer and professor professor, conjectural assertions become more and more extravagant. until science bids fair to be transformed into the art of propounding vague speculations and making them popular. observation and experiment being laid aside, or superseded by the use of the imagination. It was suggested many years ago that the phenomena in the living body resembled those observed in the chemical laboratory, then the body was called a laboratory; though if we look at a laboratory and its contents, and then look at the body and its contents, we should certainly admit that it would not be easy to name two things more unlike than a living body and a chemical laboratory. Some scientific authority remarks that many actions of the body occur independently of the will; another rises up who declares all actions so occur, and that there is no will. Then certain actions, if only superficially considered, are shown to be something like those of a machine. The body is compared with an automaton,—with a machine. It is next affirmed that the body is a machine, and that all the actions going on within us are mechanical. What we call *mind* is but the result of physical changes in brain matter, and the brain, it is avowed, is mere machinery, which works only when it is acted upon by oxygen, &c. It may be *wound up* by food, as a watch is by a key. Then it is easy to clinch the

matter with this kind of argument—As the keys of watches and food both consist of material particles, and as a watch will not go without being wound up, and an animal will not go without food, the latter is "wound up" by the food as the former is "fed" by the key. Clearly, then, watches and animals are mechanisms, and are governed by the same physical laws, &c., &c. According to physicists, there is every reason why we should take this view. It is not right to resist evidence, so we must believe that we are "wound up" by our food just as we wind up our watches by the key, and as everything that is capable of being "wound up" must contain wheels and springs, it is obvious the body is made of wheels and springs. No one has found wheels and springs in any living body, but that is of no consequence, as wheels and springs, or something analogous to wheels and springs, may be found any day, and if they are not found in our time, they will be found in the time to come, as has been decided by physicists, who belong to the class of "privileged spirits," and know how to use their imagination aright. As has been said, the question that concerns us is, *what is the truth?*

Although no machinery has been found in a living thing, the latter may still be a machine, for does not a watch when called by a physicist "a creature" change its nature, though it may not have been proved to grow and to eat grass like an ox? "Science" is progressive. If physicists are not to be allowed to call living things "machines," and machines "creatures," they will protest that, in consequence of the bias of previous education, people are as yet unable to understand the new truths; but the next generation will, perhaps, be in a more fortunate position and, not being

biassed by previous education, will be prepared to receive the new discovery, that all living things are machines and that all their actions are mechanical.

It has been recently remarked, by Professor W. K. Clifford, but not in joke, that the objection to the doctrine that we are automata is derived from the conception "of such automata as are made by man!" We are intended, of course, to think, not of the imperfect automata made by man, constructed in a definite way, with springs and wheels and levers, on certain known mechanical principles, but of the perfect automata, constructed in the physical imagination. Between the latter and man there is supposed to be the greatest resemblance. In fact, men and animals are like automata that are not automata, and conscious beings are like machines that are not machines. We were not made, but "we made ourselves," and by "natural selection" "all the actions of our ancestors are built into us and form our character!" So our faults and failings are due to the short comings of our ancestors. We are responsible only for what "the human race will be in future." The author of these words remarks, in one or two places, that a statement made or supposed to be made by someone, is not "untrue," but that "it is nonsense"!

Physicists are not content with invading departments of knowledge in which they have not worked, and giving an interpretation of facts which is unjustifiable, changing the meaning of words, and, in short, making themselves notorious, but they must insinuate that certain views which they pronounce absurd are generally believed, while in fact the views stigmatised are not, and have not, been entertained. We have been told over and over again that neither plants

nor animals generate anew or create either matter or force, although no one has expressed the opinion that living things did create anew matter or force. The creation anew of matter and force is not however the question, and physicists know that it is not, but they want to make people think that those who attribute actions peculiar to living beings to vitality are not worthy of being listened to, so they try to excite prejudice against observers who believe in vitality by attributing to them views which no one in his senses could entertain, instead of meeting them fairly and showing how the actions peculiar to living beings are to be explained by physics, as the physicists affirm is the fact. To say vital as well as physical phenomena are under the dominion of universal physical law, is simply begging the question, as it has already been begged a thousand times. By no physical law known can the movement of a particle of living matter be accounted for. Neither has any mechanism been found to account for the phenomenon.

The difficulty is to get the real issue fairly before the public. Physicists laugh to scorn the idea of vitality, but cannot prove that physical forces effect the changes attributed to vital power, or that there are no active powers or forces in nature, except physical powers and forces. They try to delude people into accepting their dictum by inculcating faith in themselves. They say they appeal to the reason, but they do not do so, and it is clear that some are conscious that they do not do so, because they threaten and prophecy and sneer at views with which they do not agree. Threats, prophecies, and sneers may convince where reason fails, but under no other circumstances is it possible that such expedients should succeed. Some of the party seem to

run wild and vie with one another in the absurdity of their conjectures. Some try to impose upon the public by the arrogant attitude they assume towards authors and investigators who are, in every sense, their equals—patronising this one, tolerating that, and dismissing another as if beneath contempt. And then they complain of the tyranny exercised towards them because they advocate liberty of thought.

But has not the materialist school, from Lucretius to our own time, behaved at least as unjustly to the teachers of the old faith as the latter have behaved to them? Materialists looking from the side of observation and experiment and scientific enlightenment and hope, have no excuse. It cannot be necessary that religion should be condemned as the first step in the proof that all the actions of living things are mechanical. Lucretius of old would surely have gained more disciples had he steadily pursued his course of teaching what he knew of the nature of things. But instead of allowing a little time for his pupils to acquire a taste for the studies he loved, he fiercely attacks what he calls the superstitions of his time, and condemns the priests. Though nearly two thousand years have passed, the followers of Lucretius have not yet learnt that it is their business first to teach new facts ; and that it will be time to overthrow the old ideas when the new truths shall have been firmly established. But the zealous teachers of the new philosophy cannot wait. They exhibit the same injudicious haste in attacking the old faith and its followers. They are not content to let old superstitions die out or rust out. They must actively crush them out. Moreover it is certain that if only a very few of the confident assertions made by new philosophers

and repeated over and over again had been shown to be based upon facts, no active efforts would have been needed upon their part to destroy the old faith. But is it not feared by some of our confident teachers that some of their cherished dogmas will, after all, find their resting-place among the superstitions of our time? Is not the idea of the *formative* power of the sun a superstition? If the belief that the sun can form and build organs and make vegetables and animals is not a superstition, what is it? Is it "nonsense"?

It seems doubtful whether the grand tenets of the conjectural philosophy, clothed in the most eloquent language, would commend themselves to men's minds unless the old religious beliefs were held up to ridicule. And it does not seem very likely that any persons will be persuaded to accept many of the new notions, unless they can be convinced in the first instance that the ideas they had entertained were very foolish indeed.

Probably few thoughtful people would, however, have supposed that anyone holding a responsible position would have ventured to hint publicly that the God who is now being worshipped by millions is a Deity of the human type—man-like. It is gravely intimated, that the God who is worshipped by us, and whom the best and wisest in previous ages have worshipped, is a Creator who is supposed by those who worship Him to work as men work! It is nevertheless a fact, that the President of the British Association speaks of God as a "man-like artificer"—a creative Power that works after "human fashion,"—an artificer "fashioned after the human model, and acting by broken efforts as man is seen to act."

Now, I would ask whether, if such machines as those we

make sprang up apparently of themselves, materialists themselves would not believe in a God? Would they not argue somewhat in this way? As man can only make the machines by first constructing the pieces, and then fitting them together, and as these pieces could not make themselves, and then put themselves together, ought we not to attribute the act of the springing up of the machine to some force or power we know nothing of experientially, and which we do not know how to investigate? This, it is true, would be only an approach to the idea of a God *able to do that which man could do*; but surely a power that could make watches and engines like those made by man, but not in the way in which man makes them, would be a God.

The God whom men worship makes not machines, and so materialists naturally deny the possibility of his existence, but it seems hard that not content with denying the existence of the only God of whom they are able to conceive, they deny the existence of any God whatever, and affirm that the only God others can believe in is a God that works after the manner of men—which is not true. The materialist who by his belief in the infinite promise and potency of the material atom proves himself to be all faith, ought surely not to be too hard upon his fellow creatures who so far have only attained to a belief in a supernatural agency having infinite power, wisdom, and goodness. Far less should he, discarding logic and giving way to anger, accuse us of believing in a man-like artificer. His material atom with promise and potency contributes to form the molecular machinery of his imagination, which does in his imagination work very like machinery made by man, but certainly no living thing in its manner of work,

in any degree resembles the manner in which any machine works. We in our weakness, therefore, attribute the difference between the two to the circumstance that the living thing was ordained and made by God to work as no machine made by us could work. Is it possible that the promise, and potency, and molecular mechanism of the material atom of the materialist imagination do not satisfy the materialist reason, and so the materialist is obliged to resort to the expedient of trying to persuade himself that after all the God in whom others believe is only a "man-like artificer," "fashioned after the human model," and that all but the very few who like him follow the potentiality of the atom, help to make up a crowd of "rash and ill-informed persons," "biassed by previous education" utterly beneath notice?

Such very unfair remarks about Deity may excite indignation in many minds, but it is possible they were made for this very purpose; for there can be no doubt an hypothesis however extravagant stands some chance of being accepted if only its advocates can excite the anger of those who are likely to be opponents, and in this certain classes of speculators will succeed if only they are ingenious as well as unjust. Those who feel angry and indignant must, however, remember that nothing will be gained by outbursts of injudicious uncompromising invective, and they must abstain from the wholesale condemnation of science when they try rightly to expose unscientific extravagance and pretence. Than science nothing can be purer, more innocent, more progressive, more true; but science must be distinguished from dogma that is called science.

It has often been said that *science* is hostile to religion, but this is not an accurate statement, for hostility is un-

known in *science*. Some of the followers of science have done things in her name which they ought not to have done, and the same may be said of some of the followers of religion—but, nevertheless, in spite of all that has been done and that may be done, religion and science are and must remain to all time pure. It is much to be regretted that this point is not more insisted upon, and especially by some who hold high positions as teachers. Scientific errors cannot be too thoroughly exposed, or scientific arrogance too severely censured or too sternly rebuked ; but it is a pity that the eloquence of theologians should be thrown away in the condemnation of science. It is unfortunate that comparisons should be instituted which I fear when calmly considered will be found as little in accordance with reason as with good taste.

Some remarks said to have been made by the Bishop of Peterborough must be noticed here. The bishop, preaching on Advent Sunday (November 30th, 1874), is reported ("Times," December 1st, 1874) to have "compared the history of the four Gospels with the 'Gospel of Science,' which had now so many prophets and apostles." Could comparison be more objectionable or more unjust and indefensible ? I dare not express an opinion whether the word gospel is properly used, but I have no hesitation in declaring that the word science is quite out of place and its meaning sadly perverted. The bishop very rightly condemns certain dogmatic statements made by individual scientific men ; statements which he knows as well as we know, are based on error and founded upon erroneous interpretation or upon actual fiction. It is of such unreliable statements that what he calls the "Gospel of

Science," is made up. This Gospel makes us, he says, "mere automatons, mechanically moved according to our molecular structure; moved by atoms coming none knew whence and going none knew where." If this be a gospel it certainly is not of "science." Again, he says, it "taught mankind to live as the brutes in which the strong trampled down the weak and poor"—and so on. Now is it not strange that the Bishop of Peterborough should have spoken thus of "science"? What he means, is, no doubt, that certain individuals have forced into notoriety the doctrines he very properly condemns, but it would surely have been the braver and wiser course on his part to have attacked and overthrown the absurd notions instead of attributing them to "science," and holding up to condemnation such a travesty of science as is expressed by that unfortunate phrase "the Gospel of Science."

On the other hand, the undecided or apologetic tone adopted by many who express themselves very anxious to controvert false scientific doctrine, and the extreme consideration and tenderness displayed in criticising and objecting to hypotheses which clearly rest only upon pure conjecture, and the authority of the conjecturer, are calculated not only to confirm many half-hearted partial converts to physical doctrines of life, but to largely increase the number of the followers of materialism. Not a few of those who oppose the most flagrant of the pretensions of imaginative science, so qualify the objections they raise as to practically admit the validity of the hypothesis they protest against.

In his essay, read before the Church Congress at Brighton, the Rev. C. Pritchard tells us, that it is certain "that our own physical frames, *our mental and moral constitution*, are

arranged on a much more mechanical principle than had hitherto been conceived." I should like him to illustrate the mechanical principle he refers to in the arrangement of our mental constitution, for it is by no means clear to what he points. Moreover, he says he cannot accept any of the postulates of the new philosophy "*in their entirety*," because he is "a student of nature." It would be interesting if Mr. Pritchard would publicly state what portion of the postulates quoted by him he accepts, and define the *substratum of truth* he conceives exists in each one of them.

What vestige of "substratum of truth," I would ask, can be discovered in such a postulate as the following, which is the substance of the first of the four quoted by Mr. Pritchard,—that the potential of all things terrestrial, including man with all his powers, was originally contained in the atoms of a nebulous patch of light? Or in this, which is the second,—that the present state of things has been brought about through the natural interaction of atoms or atomic forces? Or in this, which is the third,—that throughout nature there are no certain tokens of design? Or in this, which is the last referred to by Mr. Pritchard,—that if there be an intelligent Author of nature, an absolute Supreme, He is to us unknowable?

If there is truth in the above postulates, by all means let it be pointed out and estimated with scientific accuracy, so that we may be able, not only to acknowledge it, but to teach it and spread it far and wide. But, on the other hand, if unprejudiced intelligent men cannot discover any truth in the positive statements that have been asserted and re-asserted during the past ten years, let us not hesitate for an

instant to insist that it is the plain duty of those who adopt these views to immediately state their reasons. If, after examination, these be found insufficient, let us try to free ourselves from the nebulous perplexity in which we have been entangled, and let it be publicly announced that facts cannot be adduced in favour of the physical doctrines of life, and that the evidence upon which these rest will be sufficient to satisfy those only whose minds have been biassed by a long course of preparatory training in physical conjecture, and the art of discovery in the imagination.

And now I shall advert to a widely accepted modification of our views concerning the nature and attributes of God which is no doubt due to a very hasty and indiscriminating reception of those ideas which make up the doctrine of the so-called evolution of things. It has been said, that the idea of Omnipotence endowing matter with its potentialities for once and for all in the first beginning, is exalted and grand—but nothing is to be gained by contemplating the grandeur of that or of any other doctrine. By stripping Omnipotence of power, and by forcing back the period of its operation to a period remote beyond conception, the mind, it will be found, fails to appreciate the difference between the idea of a Providence removed so far away from itself and the idea of no Providence at all. This, it seems to me, is one of the most pernicious of the tenets of the fashionable philosophy. Those who accept this view cannot halt here, but must certainly go farther. God is reduced to little more than a creative impulse communicated to matter from the first, and constituting one of its potentialities. From that first moment to this, matter, with its associated potentialities, is held to have been under the dominion

of inexorable and unchanging law only. Differentiating through the ages, matter and its forces are supposed to have formed the infinite series of living things, which have been ever undergoing slight modifications through the ages, until at last has come thought, "as much a function of matter as motion is." Suppose, it is said by accommodating religionists, these new doctrines should turn out to be true, it will only be necessary that the period of God's creative interference should be removed in imagination somewhat farther back into a past more remote than we had before considered probable. We should still have a God—a Creator of all.

But surely the first consideration ought to be, not to what extent such a view would modify the conclusions now generally accepted concerning the nature and attributes of God, but simply whether or not the suggestion receives support from new facts which have been discovered. At this time, however, it is certain that everyone who modifies his conception of Deity in the manner referred to, accepts as true, and without examination or enquiry, statements which are made upon authority only, and which, like many highly authoritative statements recently given to the world, *may* turn out to be altogether false.

The whole idea rests upon a postulate unproved, and at this time unprovable—the postulate of the application of the law of physical causation in every region—universally in fact. This postulate I cannot admit. Still what will seem to most people a very small thing for an opponent to ask for would convince me, or would at least induce me never again to offer an objection to it. I only ask that one single living particle should be adduced

whose machinery can be demonstrated, and the phenomena of which are to be adequately explained by physics. But this cannot be done. The lowest, simplest living thing that is known exhibits actions which no physical law can account for, and which can only be explained by assuming powers or forces which are not physical. Nevertheless, the number of people who accept or seem to accept the physical doctrine of life is, I believe, on the increase. I do not consider it likely that many well-informed persons implicitly believe the general statements made in favour of physical doctrines of life to be literally true, but a vast number certainly consider that there is much more of truth in them than those who have thoroughly examined them, acknowledge, or than appears on the surface. But it is only this sort of vague half acquiescence which is looked for by the advocates of the physical doctrine. If the public will only give physicists credit for having rendered it probable that, as Mr. Pritchard puts it, our *mental and moral constitution* is arranged "on a much more mechanical principle than had hitherto been conceived," that will be quite enough for the present. A further stage of progress in the new faith will soon and certainly be reached. Yet I have no doubt that if it were possible to place the arguments which are advanced in favour of such views fairly before the public the verdict would be entirely against their acceptance. But I freely admit people may fairly say, "we cannot be expected to inquire into all the details upon which these conclusions rest. All learners must *trust* and largely trust their teachers. We cannot believe that distinguished scientific men of well earned reputation can have imposed upon themselves, and upon us, to the extent they must have done if these physical

doctrines of life, now so confidently and so widely taught, are not true." But how many there are who are most anxious to believe these doctrines, how many who are always ready to listen attentively to anything scientifically racy and extravagant! while, on the other hand, is it not equally certain that little attention would be paid to arguments which showed, however conclusively, that the extravagant statements were not to be relied upon? If a great scientific authority comes forward, and says, "We are all machines," he excites interest and surprise. The attention is fixed, and people wonder what will come next; but if an observer begins his discourse in this way—"Now I am going to prove that we are *not* machines," the thought that would probably first present itself to the majority of his audience is "who could have supposed that we were machines?" and the next, perhaps, would be "what fools this man must think us; he actually considers it necessary to seriously adduce arguments for the purpose of convincing us that we are not what we know we are not, and cannot possibly be—as if we were not aware that we had grown, and as if we required any proof to convince us that machines do not grow." But, however this may be, it is quite certain that many people do believe that there is truth in the doctrine that men and animals are machines. The whole question is involved, and becomes daily more and more complex. So much confusion has lately been introduced by physicists, who have never studied the ordinary phenomena characteristic of and peculiar to all life that it can scarcely be expected that the public will fairly examine the question and study its details. Still I do not understand why people are not to be permitted to weigh and judge scientific statements, although they may not be scientific in-

investigators. The public does judge concerning statements upon many technical matters, into the details of which they cannot possibly enter.

There is enough to excite caution, if not suspicion. Let any person of ordinary intelligence only carefully take account of the manner in which many of the modern hypotheses have been put forward. Let him notice the asseverations about truth, the extreme confidence displayed, the declaration that such and such a thing only is in accordance with the tendency of thought, that people who do not believe it must be foolish or savage, or rash and ignorant, or prejudiced or biassed by previous education and nursery theology. Is there not in this much to arouse suspicion and excite distrust? Then let him take note of the arrogant bearing of those who dispense the pretended new knowledge towards those who differ from them. Let him observe the anxiety that the new doctrine should be accepted at once. This, again, is suspicious. If it is true that our progenitors were apes, it surely signifies very little whether we accept the truth this year or next. If, however, it be not true, it is of extreme importance, as regards the reputation of the advocates of the doctrine, that people should take the pledge at once, and so swell the number of believers. For, if numbers can be gained over, temporary success is at least secured, while the general acknowledgement of the erroneous character of the hypothesis will be postponed, and perhaps be put off to a remote period when it will not affect any one. Multitudes of converts are evidently desired by the advocates of many modern views. The disciples of the new faith must be supported by thousands and tens of thousands. They are the most unwearying of prosely-

tizers. Their views must be received and acknowledged to be the only views that are true. No time is to be lost, lest the ardour of the pupil for the new idea should cool. And the teachers of the new faith act wisely. They perhaps are aware that if men are allowed a little time to reflect and to think over all that they have been told, they may change their minds, and perhaps pass over to another school.

Then it is intimated very distinctly that the teachers of the new philosophy are not men who belong to the general crowd. They constitute a very small and very select body. Perhaps not more than one in a million of the people could become a new philosopher, so that we must be content to hear and believe. The knowledge is in the hands of a few, and possibly not more than five people now living understand the truths of evolution ! To this small body of privileged spirits ordinary mortals must look for light. If we sue for knowledge with humility we may be enrolled amongst the supporters of the new faith. If we merely want to ascertain exactly what the philosophers of the new school profess to have discovered, and are intolerant enough to ask how the discovery was made, and the grounds upon which conclusions arrived at are based, we shall be treated with the contempt we deserve, and shall find ourselves included in the crowd of rash and ignorant people who are hostile to "true progress," &c.

But what certainly ought to arouse suspicion to the utmost is the fact that the advocates of materialism come not only as teachers of what is said to be new, but as the destroyers of much that connects us with the past. Our old beliefs are spoken of as if beneath contempt. We are to acknowledge that we are no longer Christians. The old idea of God is

to be given up, and belief in miracles, in inspiration, in a future state, in divine government, in a supernatural, in divine revelation, in any kind of life after death are to be abandoned as foolish if harmless and innocent prejudices, by all who desire to drink of the water which flows from the hidden depths of the new philosophy. This is the preparatory step that must be taken by everyone before he will be able to perceive the potentiality of the atom and the mechanical machinery of life.

I have only lightly touched upon some of the most serious objections to the doctrine that living things are machines. Many of these seem to me to be absolutely fatal to the hypothesis that the actions peculiar to life are mechanical, and governed by physical law. But while all the evidence I can get irresistibly proves that certain actions which characterise all living things, and are peculiar to them, are neither mechanical nor chemical nor in any way physical, I do not desire to press this conclusion on others. All that I insist upon is, that the evidence upon which the new school relies should be adduced and clearly stated. So far, little in the nature of evidence has been advanced, and no evidence at all has been produced to prove that the phenomena of growth, multiplication, and formation are due to changes of the same order or in any sense at all *like* those which have been called "molecular." It is time that the prominent leaders of the new school should be called upon to more clearly explain their own doctrines. Unless they do explain, the severity and injustice with which they treat some of their predecessors must recoil upon themselves, and notably upon one conspicuous member, who has not hesitated to criticise Aristotle in words peculiarly applicable to

certain living expounders of the revived faith in materialism. "Indistinctness of ideas, confusion of mind, and a confident use of language, which led to the delusive notion that he had really mastered his subject, while he as yet had failed to grasp even the elements of it. He put words in the place of things. . . . He preached induction without practising it, inverting the true order of enquiry by passing from the general to the particular, instead of from the particular to the general."* Such, indeed, unquestionably must be considered among the very "worst attributes" of a physical investigator.

Let me now direct attention to the phenomena of the lowest simplest kind of living matter with which we are acquainted, and which, according to the views generally held, ought to be, as regards condition, very close indeed to some form of non-living matter, and should exhibit some analogy to some machine or mechanical contrivance known to physicists.

We may learn many things concerning the simplest phenomena of life by careful observation, but we shall find that the more carefully the facts are investigated the less plausible will appear the attempt to explain the phenomena by physics and chemistry. If the facts to be demonstrated with the aid of high magnifying powers are known to physicists, they are for the most part ignored by them. The facts are only referred to in a very superficial and general way, the details being altogether overlooked or very inaccurately noted.

One of the simplest living things known is a microscopic fungus, the yeast plant for example, which is a small oval

* Dr. Tyndall's Address, delivered before the British Association at Belfast, 1874, p. 15.

body about the 3,000th of an inch in diameter, that is, it would take about three thousand individual particles placed end to end to make a line an inch long. Each circular or oval particle is colourless and tolerably firm, but if pressed hard between glass, the membranous capsule or envelope may be caused to burst, and then soft colourless matter will be squeezed out. This soft material will break up into very minute particles, and each one of these, if placed under favourable circumstances, will *grow*, that is, it will take up some of the constituents around it, and will convert these into matter like itself. Not only so, but upon the surface of the little particle a change of another kind will occur. A thin membrane will be formed which is closed at all points. By this, the growing matter within will be protected, while the dissolved food will pass through it, although there are no visible openings or pores.

But what is *growth*? Would that I could persuade those who persist in asserting that living things are but *aggregations of molecules* to consider the phenomena which occur in every instance of growth! If the advocates of physical doctrines of life would only compare the *growth* of any simple living thing with what occurs in crystallization, and in the accumulation of sediment, it would no longer be necessary for observers to take exception to the confident assertions made by authorities eminent in their own departments, but apparently ignorant of what can be observed by any one who will carefully study the increase in dimensions of elementary parts of living beings during their *growth*. The "fungus-like" accumulation of carbon on the wick of an unsnuffed candle is not "growth" though Mr. Herbert Spencer affirms this to be an example of "growth;" neither is there, as he

asserts, any "community of nature between organic and inorganic *growth*." On the contrary, there is nothing in common between these two processes improperly spoken of as growth." With regard to the first instance it is necessary to ask what grows? Surely neither the wick nor the candle, for are not both consumed? Is there not loss instead of increase in weight? Is there not loss of substance? Is there not diminished light? The imperfect combustion results in the deposition and accumulation of soot which reduces the illumination, and leads to the destruction of the candle. Yet this is called *growth* by Mr. Herbert Spencer.

On the other hand when living matter *grows* there is gain of substance. There is increased capacity for action, to say nothing of the marvellous powers which are acquired by the new matter. Mr. Spencer ought to point out, without delay, what there is in common between *growth* as it occurs in all living things, and what he calls "inorganic growth." Perhaps some of his disciples will apologetically declare the comparison instituted by him is only general; a rough one just adduced as an illustration; and that it is not fair to criticise it as if it had been advanced as accurate and exact. Such comparisons, however, are certain to mislead and to confuse, and it is to the multiplication and repetition of careless and inexact illustrations that the misconceptions which largely prevail in connection with biological science are mainly due.

In aggregation and crystallization, matter simply changes place without changing its composition or characters, but in "*growth*" non-living matter *passes into* that which already lives. Its elements become re-arranged, and the matter acquires properties which it did not possess before. Who shall give us an idea of the means by which chemical affinities are

overcome and atoms re-arranged when non-living matter assumes the living state? That separation and re-arrangement of elements occur must be sufficiently obvious, because the particular substances produced when the living matter dies are not to be detected in the matter out of which they have been formed, neither can the substances in question be prepared by the chemist from the materials which compose the media from which the living matter obtains all the elements that contribute to its nutrition. Neither is the chemist able to imitate the re-arrangement effected by living matter. He cannot form out of the constituents of the pabulum substances like those which are produced by the living thing. The wonderful changes which cannot be brought about by the aid of any apparatus or machinery of which we have cognizance, are effected without any machinery whatever, and at a temperature much lower than is required for combinations and decompositions to be effected in the laboratory. Nevertheless, it will be re-asserted that living things are machines, and that all their actions are mechanical.

Each little particle of yeast may be looked upon as a sort of seed—a sporule—from which new sporules may grow. The sporule is very large compared with the most minute particles of which we have cognizance, but still it is so minute that it will easily float in air, and can be carried long distances by aërial currents. The little sporule of yeast, if placed in a weak solution of sugar in a warm place soon begins to germinate and grow. But what *begins*? the matter outside or the matter within? Does the envelope grow, or is this marvellous power of growth limited to the material enclosed? If the growing sporule be narrowly watched it

will be found that it increases somewhat in dimensions. We may be sure that the envelope absorbs moisture, and becomes softened just as the envelope or capsule of an ordinary seed does before the seed perceptibly begins to grow. Well—after a time one or more little projections are seen extending from different points of the surface of the sporule, and these gradually increase in size, but remain attached to the original mass by a narrow pedicle. After reaching a certain size they are detached, and the process is repeated. Under some circumstances the projection continues to grow away, and long ramifications result, from which others proceed at intervals. In these changes the envelope or capsule is passive. This closed capsule or "cell-wall" is formed, not by deposition of matter from the surrounding fluid, but by change of the living matter upon its surface.

The increase of the living matter within the capsule has been attributed to osmose, but if that were the true explanation, the living matter would merely be diluted by the water that passed into it. Water in which pabulum is dissolved no doubt enters, and water from which the pabulum has been separated passes out. Water, amounting to many times the volume of the yeast particle, and carrying in solution the materials for growth, must pass in during a very short period of time when growth is active. Thus the living matter increases in amount, not by osmose or by any other physical change, but by the production of new living matter. And this is due to the influence of the living matter or its powers upon the particles of non-living matter which are, in consequence, re-arranged, and acquire properties they never had before.

The formation of the bud or outgrowth is due to an ex-

tension outwards, or a moving away of a part of the mass of bioplasm from the rest. The outgrowth is not more likely to be found in positions where gravitation would be favourable than in any other parts. The power of moving from a centre is constant in all living matter. It might be said that to move from a centre was a law of living matter. Certainly it is a fact constantly observed to which there is no exception in the world of life. The tendency of particles to move away from a centre will, of course, cause fluid to flow in the opposite direction towards the centre. This, probably, is the explanation of the passage of fluid into the very substance of the living matter, a process which was attributed to attraction, osmose, affinity, and a number of other forces, not one of which, nor indeed all combined, would be competent to bring about the result. This moving away of particles from a centre is most remarkable, and the fact is of itself sufficient to destroy many of the physical hypotheses that have been proposed. The phenomenon is a sufficient answer to the dogmas that have been laid down concerning the paramount influence of matters in the environment of living matter and the hypothesis of excitation. The origin of a new centre within a pre-existing mass of living matter is proof positive that in living matter the first impulse springs *from within, not from without*, as has been maintained for many years past. The matter tends to move outwards—to increase and grow—if only external circumstances, such as temperature, moisture, pabulum, &c., will permit it to do so.

By many it is assumed that the changes which occur in the substance of living matter are of the same nature as the physical and chemical changes which go on in some kinds of formed matter and those which occur outside an organism.

It is asserted that there can be no changes which are not physical. It is assumed that the phenomena outside are of the same order as those going on in the substance of the living matter. Generally no distinction is drawn between the non-living matter and the living matter; and, by many authorities, the living matter inside an organism is ignored. People are told by physicists that those who advocate the doctrine of vitality believe in the creation of energy, and their attention is engrossed with such pertinent observations as the following:—"There is no more reason to assert that there is a creation of energy in any part of an organic body than there is to assert that there is a sky-blue peacock on the other side of the moon with forty-five eyes in his tail."

In a simple yeast fungus and every other simple elementary or uni-cellular organism, we have then, 1, externally, a sort of membrane or passive matter permeable to fluids; and, 2, within this, clear transparent structureless living matter. The outer *formed matter* is formed from, and accumulates upon the surface of the *living matter*. The formed matter is thickened by the formation and deposition of new formed matter within that which was first produced. In this way the formed matter may become of considerable thickness.

In all the higher and more complex living forms, vegetable as well as animal, the organism consists at an early period of *bioplasm* or *living matter* which divides and subdivides. In this way multitudes of masses result. Each produces formed material on its surface, and thus tissue results. Nay, in many cases the formation of a capsule, just as in the simple yeast plant, takes place.

Every tissue in the higher plants and animals, and in man himself, at every period of life, is found to be made up

of *bioplasm* and *formed matter*. Young textures consist almost entirely of bioplasm ; but, as development advances, the formed material is produced, and, in many tissues, continues to accumulate until the tissue is fully formed. The proportion of the bioplasm to the formed material becomes reduced as the texture advances in age. In many fully formed, and in all old tissues, only a mere trace of bioplasm remains.

If a perpendicular section of the tissue which forms the outer part of the skin, and is known as the cuticle, be examined, the changes taking place in the elementary parts composing it will be understood. Or, if we examine specimens of cartilage from the same species of animal at different periods of development, a good illustration of the facts will be obtained. If given areas of tissue be compared under the same magnifying power, it will be noticed that the youngest tissue contains the largest, and the oldest tissue the smallest proportion of bioplasm. In other words the formed material increases and accumulates between the several masses of bioplasm as the tissue advances towards its fully developed state.

Now allow me to impress upon you the fact that the colourless bioplasm, or living matter, which exists in all living creatures at all periods of life, from the first moment of their origination to the time of death, and, at least, in some forms even for a time after general life has actually ceased, came direct from living matter that preceded, and manifests certain phenomena not to be accounted for by physics. The latter may be grouped under : 1. Movement, 2. Nutrition and growth, 3. Division and multiplication, and 4. Formation.

Many physicists still ignore the existence of this all-important bioplasm or living matter. Not a few deny that any difference exists in the matter I have called bioplasm, and other matter of the body. Others are never tired of asserting that all changes occurring in matter must be physical, though they cannot, of course, account by physics for the phenomena peculiar to every kind of living matter. They will not attempt to explain either growth or nutrition, or movement or formation. They only re-assert that all these are due to physics. They are unable to adduce a single instance in which phenomena, characteristic of all living matter, are to be observed in connection with any one form of non-living matter. They divert people's attention by insisting that the creation of energy is impossible, as if it had been affirmed that physical energy was created anew by living matter. They arbitrarily lay down the law that all the phenomena of living beings are mechanical. It would not be more extravagant to attempt to explain the different opinions entertained by different men by "energy," than to attribute to energy the differences between a sparrow and a swallow. Energy will not account for differences in form, in structure, and in action. Energy is the same in the living and non-living, but the variety of living forms and actions is infinite. Energy no more accounts for the movements of living matter than it does for the inheritance of peculiarities of structure and action.

We have seen that the phenomena peculiar to living are not mechanical changes, and that no indication of machinery of any kind whatever is to be detected in any form of living matter. Such words as "machine," and "machinery," ought not to be used in speaking of living

matter. Before a machine can be likened to any kind of living matter, one must be found which will not only form its own wheels, levers, &c., from unwrought metal, but which can produce the metals from their salts. Brass wheels, for example, from sulphate or other salt of copper, and sulphate or other salt of zinc. The machine must be able to repair itself out of similar constituents. It must be able to produce smaller machines, which possess the power of growing into machines in all respects as powerful as the original.

Such statements as "living things are machines," and "all the actions of living things are mechanical," "an animal is an automaton," may assist in establishing "the crude materialism of the savage," but cannot, in any way, advance natural knowledge. The difference between every known form of living matter and a machine is *absolute*, and the assumed gradation from the non-living to the living does not exist in nature.

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